FUEL EFFICIENCY 1

ENERGY AUDITS

BEST PRACTICE PROGRAMME

Energy Efficiency Office

DEPARTMENT OF ENERGY

Energy audits

Reprinted 1988
Reprinted 1989

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Introduction

An energy audit is a fundamental part of any energy management programme of any organisation which wishes to control its energy costs. This booklet describes the two essential parts of an energy audit, the first being a cost and use analysis whilst the second part will help the reader understand more about the way energy and fuel are used in the factory or building. It will also help identify areas where waste can occur and where scope for improvement may be possible.

This booklet is aimed at the Chief Executive of an organisation who should ensure that his energy manager, management and audit accountants implement the recommendations.

Why is an energy audit necessary?

Energy is an expensive item in the national budget. In 1982 for example, it cost £36,000 million. A 10 per cent saving in energy use would save the nation £3,600 million. What would this saving mean in your organisation? It could mean increased profits, more competitive pricing, more money available to improve services to the public. An energy audit would enable you to identify waste of energy and reduce the cost.

Do you know how energy prices have affected your costs? Figs 1, 2, 3 and 4 show how fuel prices have risen over the past seven years. They may have levelled off recently, but for how long? Can you afford to be complacent about your energy costs in an increasingly competitive world? An energy audit will help you to understand more about the way energy is used in your organisation and help control energy costs by identifying areas where waste can occur and where scope for improvement may be possible. It is normal practice in a company to carry out financial audits for management control purposes, for example budgetary control, cash flow data and annual accounts. With today's energy costs it makes sense to treat them as a separate item and not include them in the overheads.

Fuels Used by Manufacturing Industry

Fig. 1 *Price per kWh in pence*

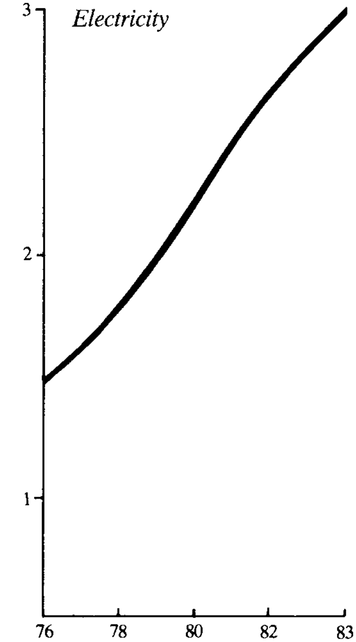


Fig. 2 *Price per tonne in £*

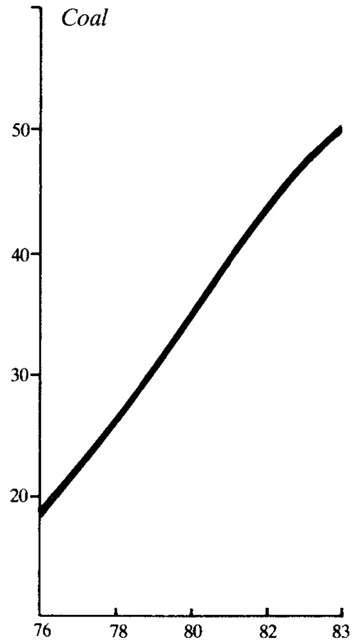


Fig. 3 *Price per litre in pence*

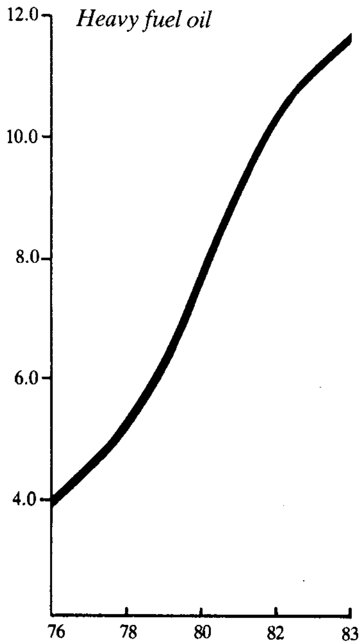
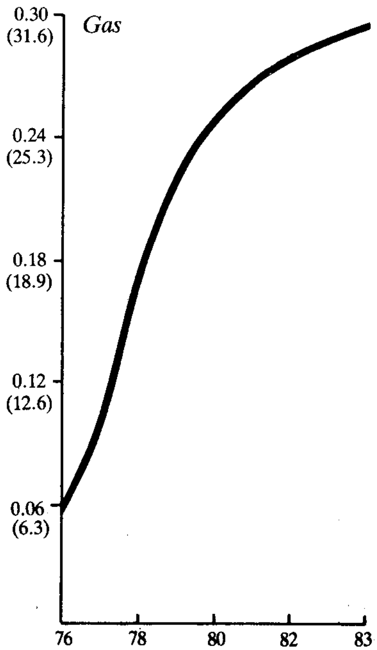


Fig. 4 *Price per MJ (therm) in pence*



How do you start an energy audit?

Firstly, attempt to complete Table 1 for fuel and energy used in your establishment for the last financial year.

To help you complete this table, the energy consumption and costs of the imaginary company, the 'Square Circle Manufacturing Company', are given in Table 2. To complete the penultimate column the conversion figures given in Table 3 were used.

Since Britain is in the process of adopting a new basic system of weights and measures, the Système International d'Unités (SI units), Imperial and SI units are both employed in this booklet. However, when figures are quoted in both units, they are intended to be of the same order but not necessarily accurate conversions of one another.

NOTE: The fuel and power prices used in this booklet have been calculated from information provided quarterly by a pane of about 900 large fuel consumers within manufacturing industries.

Table 1: Quantity of energy used and its cost for the last financial year

Type of energy	Tonnes (tons)	Litres (gallons)	MJ (therms)	kWh	Price/ unit	Cost (£)	Common basis MJ (kWh)	Cost per MJ (kWh)
Solid fuel								
Liquid fuel								
Gaseous fuel								
Electricity								
Other								
Total								

Table 2: The consumption and cost of energy used by the Square Circle Manufacturing Company for the last financial year

Type of Energy	Tonnes	Litres	MJ (therms)	kWh	Price/unit of energy (£)	Annual Cost (£)	Consumption Common basis MJ (kWh) $\times 10^6$	Unit Cost per MJ (kWh) (p)
Solid fuel	250				47.9	11,975	6.99 (1.94)	0.17 (0.62)
Liquid fuel		336,000			0.108	36,288	13.74 (3.82)	0.26 (0.95)
Gaseous fuel			186,000 (1,760)		0.0027	502	0.19 (0.05)	0.28 (1.01)
Electricity				360,000	0.03	10,800	1.30 (0.36)	0.83 (3.00)
Total						59,565	22.20 (6.17)	

NOTE: This table illustrates the quantity and cost of energy used. To discover whether it is being used efficiently or wastefully the figures should be broken down and examined in detail. Remember that this comparison table is telling you the average cost of your energy as purchased. It tells you nothing about how effectively you have used the energy you bought.

Table 3: Energy Conversion Factors

Type of energy	Heat value of energy inputs	Megajoules/ tonne etc.	kWh/tonne etc.
Coal[1]	269 therms/tonne	27,500/tonne	7,640/tonne
Heavy fuel oil[2]	423 therms/tonne (0.39 therms/litre)	43,200/tonne	12,000/tonne
Medium fuel oil	427 therms/tonne (0.39 therms/litre)	43,600/tonne	12,110/tonne
Gas oil	445 therms/tonne (0.36 therms/litre)	45,480/tonne	12,630/tonne
Gas	1 therm	105.5/therm	29.3/therm
Electricity	0.0341 therms/kWh	3.6/kWh	1/kWh

[1]Coal — The conversion factor is affected by the quality of the coal, particularly the moisture and ash content.
[2]Figures are given for the most common grades of heating oils — your fuel supplier can provide details for the particular oil you buy. More detailed conversion factors are given in Appendix 2.

The next step — setting up an energy audit programme

Having completed Table 2 one is now aware of what the cost of energy was last year and how much was used, the next step is to set up an energy audit programme. This should be undertaken jointly with the Energy Manager, Accountant and other interested parties who should analyse current energy use by activity, examine ways of cutting out waste, and draw up an energy budget and forecasts for this and future years. A useful feature of this exercise is to set targets for improving energy use which, whilst being realistic, should represent a challenge. This exercise should start by completing an internal control questionnaire as shown below.

Energy conservation audit
Internal control questionnaire

Name of company ....

Location..

Official(s) interviewed ....

A Control of energy

1 Who is responsible for energy management?
Name
Position in organisation
Who does he/she report to
Full time or part time
Qualifications, relevant experience
Staff

2 How is energy consumption reviewed?
From head office or on location
Continuously or periodically
According to a plan or irregularly

3 If periodically, when was last review?

4 How is energy consumption analysed:
by department;
by product;
by source;
by month or number of working days (shifts) per month (see Appendix 1);
by cost;
between lighting, hot water, space heating, power, refrigeration etc.;
between office, factory, warehouse, transport etc. (see Tables 4, 5, 6)?

5 Does analysis identify the relationship between consumption of energy and level of activity?

6 What units of measurement are used?
(It may be useful to convert consumption of different sorts of energy into one unit — also into money.)

7 **(a)** What are the metering control arrangements?
(N.B. This question includes:
how frequently are readings taken;
to what extent is there sub metering;
what records are kept?)
(b) Is sub metering adequate?
(c) Should an energy management system be installed?
(d) Would central data logging be cost effective?

Coal or other solid fuels
Steam
Gas
Electricity
Liquid fuels
Water
Others

8 Is there an energy consumption forecast/budget?

9 Have standards been set — i.e. standard energy consumption for each process or building?

10 Is consumption compared with:
previous periods;
other locations;
other companies;
other industries ?
(Does the comparison take account of weather conditions and days worked?)

11 Has the management set targets:
for absolute levels of consumption;
for levels of consumption based on activity;
for levels of idle time;
for percentage cuts in consumption?

12 **(a)** Does management consider information on energy consumption an essential part of the management information system?
(b) If not, why not?

13 What steps have been taken by way of propaganda or education of employees, to promote energy conservation?

14 What steps are being/have been taken in re-cycling energy —
e.g. sale of by-products or scrap (having intrinsic energy content);
reclamation of energy as heat from air, water, hot products etc;
using waste as a fuel?

15 To what extent is planned maintenance in operation?

16 How often are different classes of plant inspected or tested —
e.g. for corrosion, cracking, fouling, leaks, malfunctioning steam traps, inaccurate or inoperative control devices?

17 Who controls capital spending budget?

18 **(a)** Is there a list of energy saving investments under review, ranked in order of priority, with detailed costing and pay-back calculation?
(b) If not, why not?

19 Has a Sankey diagram been prepared?

B Sources of energy

1 What are the sources of energy used?
Coal or other solid fuels
Gas
Electricity
Liquid fuels
Other

2 **(a)** What tariffs are used?
(b) Why?
(c) When were they last reviewed?
(d) Can off-peak tariffs be used?
(e) Can you cut maximum demand?
(f) Can you improve power factors where it is economical to do so?

C Uses of energy

1 Buildings
(a) Is insulation adequate:
roof;
walls;
floors;
doors;
windows?
(b) For what period are buildings heated and lighted:
hours per day;
days per year?
(c) Is heating controlled manually; by thermostat, time clock etc?
(d) What is the temperature?
(e) Could the temperature be reduced?
(f) Does temperature vary from one part of the building to another?
(g) Is ventilation excessive (often the major cause of heat loss)?
(h) Are parts of the building heated unnecessarily?
(i) Are energy efficient lighting fittings and controls used?

2 Oil Storage
(a) How are storage tanks heated?
(b) Are they kept at most economic temperature?
(c) Are they adequately insulated?

3 What are areas of high energy consumption?

4 Is there any risk/evidence of unauthorised use or leakage?

5 What further steps are being considered to optimise savings and profits?

6 Processes
(a) Are pipes and tanks adequately lagged?
(b) Is condensate recovered?
(c) Is boiler and furnace efficiency tested?
(d) Are process temperatures at lowest essential level?
(e) Is the optimum blowdown on boilers maintained?
(f) Is refrigeration plant operating efficiently?
(g) Are there leaks of steam, hot water or compressed air?

Table 4: Environmental

Type of energy	Offices	Factory	Warehouses
Energy use			
Lighting (kWh)			
Hot water MJ (kWh)			
Space heating MJ (kWh)			
Number of hours in actual use/month			
Space heating ratio			
MJ/m^2/month (kWh/ft^2/month)			

Table 5: Production

Type of energy	Machine shop consumption cost	Process A consumption cost	Process B consumption cost	Boiler house consumption cost
Energy use:				
Electricity (kWh)				
Lighting				
Machines				
Compressed air				
Heating				
Gas MJ or kWh (therms)				
Oil litres or MJ (kWh)				
Solid fuel inc. waste (tons or tonnes)				
Process heat and power				
Steam kg or MJ (lb or kWh)				
Electricity (kWh)				
Units of output				
Total energy used[1] (kWh or MJ)				
Total energy cost (£)				
Energy used/unit of output				
Energy cost/unit of output				

[1]Table 5 is only one way of examining the breakdown of energy use and it should be adapted to meet the particular circumstances of your company. The main point is to measure the energy use and analyse the breakdown of that use.

The internal control questionnaire will have highlighted the weaknesses and strengths of the energy management programme. One weakness which will be found in many organisations will be a lack of statistical information on the breakdown of energy use between the various activities or departments and Tables 4, 5 and 6 suggest an initial approach to collecting information on energy use by the various sectors which can then be audited separately. The larger the energy consumption and the greater the total energy cost the more detail and breakdown are required. Try to identify specific areas of consumption for example, offices, factory premises, machine shops, process units, refrigeration plant, transport. Use monthly figures but adjust for working days and take account of variations in stock levels of liquid and solid fuels.

Table 6: Transport

Type of energy	Internal transport	Delivery, etc.
Petrol (litres)		
Diesel (litres)		
Lube oil (litres)		
LPG (MJ or kWh)		
Electricity (kWh)		
Vehicle mileage		
Freight carried (tonnes)		
Oil/petrol		
Consumption (per tonne km or per ton mile)		
Cost of fuel (per tonne km or per ton mile)		

Are there blanks in Tables 4 to 6? Are there ways and means of making measurements or estimates?

What is the next stage?

Having collected and analysed energy use and costs data the next stage is to examine ways in which the audit procedure can be improved and opportunities for energy saving identified.

The best way of achieving this is to set up an audit programme such as the one given below. This should be reviewed at least annually and form part of the overall review of energy use and cost.

General Audit Programme

A Records of consumption

1 Produce detailed analysis of energy consumed over the most recent year. Show the account, and cost per unit, of each fuel. (This will be used for the purpose of the current audit and for providing a base line for comparison with later years.)

2 Review existing records of consumption and determine if adequate information is available to management.

3 Produce Sankey diagram. (See page 15.)

4 Compare consumption with:
(a) other locations;
(b) previous periods;
(c) budget.

5 Compare standard consumption to actual for each process or operation, and identify losses and improvements.

6 Test meter readings against records.

7 Test records against invoices.

B Maintenance

1 Review records of maintenance engineer.

2 Determine whether he works on a planned maintenance basis and consider whether he should do so.

3 Check that all control mechanisms are effective and frequently tested.

4 Consider whether further instruments would be useful in measuring or controlling particular parameters (e.g. electricity consumption, temperature, pressure, humidity, flow rate).

5 Determine whether maintenance is adequate (e.g. annual cleaning of boilers is unlikely to be sufficient to avoid fouling and corrosion of tubes, check for carbon monoxide production from gas burners).

6 Consider how maintenance could be improved:
(a) more skilled manpower;
(b) design change (e.g. fitting of by-pass facilities, pipe line strainers, sight glasses, etc).

7 **(a)** Review fuel storage and handling.
(b) Consider whether temperatures are adequate or excessive.

C Environment

1 Review space heating
(a) determine whether occupied volume per person is the minimum feasible, and whether any unoccupied space is unnecessarily heated
(b) check that heating installation has fast response to control
(c) check that control devices are protected from unauthorised interference
(d) check that temperature, air movement and ventilation are not excessive
(e) check whether temperature gradients exist in tall buildings
(f) ensure windows are not used for temperature control in heated buildings
(g) check insulation throughout
plant, including tanks and pipe runs,
roofs,
walls,
doors, windows etc.
floors
(h) check that systems are properly integrated (i.e. heating and cooling plants do not conflict)
(i) review heating installation, and consider improvements in control.
(N.B.: The purpose of this audit step, in conjunction with 'A' above, is to determine when and how much heat is lost, with a view to recommending remedial action, if appropriate.)

2 Review lighting
(a) consider if the most efficient form of lighting is used for each purpose
(b) check lighting levels do not exceed the recommendations of the Chartered Institution of Building Services Lighting Division
(c) is proper use made of natural daylight?

D Electricity

1 Review tariffs or contracts for supply of energy
(a) ensure the most appropriate tariffs are used, discuss with suppliers if appropriate.

2 Check all reasonable steps are taken to minimise peak demands for electricity, e.g.:
(a) re-schedule tasks to off-peak periods
(b) use an emergency type diesel or gas turbine driven generator as booster/alternative to electricity, preferably including waste heat recovery
(c) monitor consumption precisely
(d) use maximum demand meter.

3 Consider the feasibility of using night rate electricity.

4 Consider sub metering and use of portable watt meter so that consumption can be broken down into controllable units, i.e. cost centres, thereby making some individual personally responsible.

E Personnel

1 Consider if specialist workers are adequately trained and motivated, e.g.:
energy manager
maintenance engineer
furnace operator
instrument engineer.

2 Review energy conservation propaganda or education, e.g.:
posters
house magazines
circulars
requests for suggestions from employees
talks and short courses
involvement of unions.

F Capital investment

1 Review energy related capital projects under consideration
(a) check calculation of return/pay-back (see example in Appendix 3)
(b) review arguments for and against making the investment,
(c) check that tax implications and any grants are correctly taken into account.

2 Review refurbishment of major energy using equipment such as furnaces, boilers and process equipment:
(N.B.: About 86 per cent of all energy used by industry is converted in boilers or furnaces.)
(a) consider whether they should be replaced (in many cases the energy saving could be a 50 per cent return on capital),
(b) consider whether they should be modified:
by pre-heating air,
by adding metering facilities,
by recovering waste heat,
by improved insulation,
by replacing burners (modern burners have improved turndown capability which is useful if there is a fluctuating load/demand and can show a 30 per cent return on capital),
by adding economisers,
by returning condensate to boilers,
by improved controls,
(c) consider size *vis-à-vis* demand,
(d) determine whether use of cooling water is restricted to an economic level,
(e) consider conversion to coal for processes and boilers to reduce energy costs.

In larger organisations it may well be appropriate to carry out subsidiary energy audits of separate activities such as manufacturing, transport or building services to supplement the information in Tables 4, 5, 6.

Manufacturing Audit

A

1. Carry out relevant sections of General Audit programme.
2. Analyse use of energy.
3. Note which machines or processes use most energy.
4. Check lubrication procedures on machines and relevant industrial processes, e.g., cold reduction of metal. Too much wastes oil, too little can increase power requirements and harm machinery.
5. Check whether machinery is running unnecessarily.
6. Review product quality, is it in excess of customer or process requirements, if so, energy could be wasted.
7. Check for heat leakage on process plant, furnaces, etc., using infra-red thermography.
8. Review scheduling of large energy uses, to reduce M.D. charges.

B Capital Investment

1. Analyse pump and fan power requirements. Two speed or variable speed drives should be considered and pumps and fans should be checked for wear or flow obstruction.
2. Examine the scope for combined heat and power. If appropriate, choose a system which closely matches your heat and power requirements.
3. Check whether there are opportunities for recovery of waste heat and that there is a requirement for the recovered heat.
4. Consider any other possibilities for recycling energy.

Transportation Audit

1. Check routeing and load schedules of vehicles, if possible match load to vehicle size.
2. Check vehicles are serviced regularly and that fuel consumption is regularly checked. Each vehicle should have a comprehensive record of activity and maintenance.
3. Check unauthorised and private usage.
4. Consider speed limiting devices and automatic engine cooling controls, and other energy saving features.
5. With ships, friction accounts for over 60 per cent of total resistance; hence it is essential that hull surfaces be cleaned and coated at regular intervals.

Further steps to take in the Energy Audit

1 Existing data relating to energy consumption

Gas, electricity (and incidentally water, which may be worth investigation) are usually metered. As a first step, have these meters read weekly or monthly. Solid fuels are invoiced by weight. Liquid fuels may be invoiced by weight or volume.

After allowing for differences in stocks, find out which are the main consumers of energy. Take note of all users. Direct measurements by installed meters are to be preferred. (Notional figures may have been assumed in standard costing and these may need revision.) At an early stage, eliminate loss from leakage and pilfering by using a better standard of maintenance and by checking the efficiency of fuel consumed, not just purchased.

Computerised billing and the incorporation of data collection and analyses in modern energy management systems provides an easy way of gathering energy use data and correlating this with internal or external factors such as changes in the level of production or the weather.

2 Relation to internal and external factors

When comparing one month's energy use with another, last year with this year, the seasonal factor should be taken into account. Space heating, for instance, will figure prominently in the winter months' energy use, process energy may be affected by cooling water temperature or factory air conditioning may be required in summer. These external factors should be recognised and compensated for. For space heating, the degree day concept can be used.

The degree day is defined as the daily difference in °C (°F) between a base temperature of 15.5°C (60°F) (the outside temperature below which the heating system requires to be operated) and the 24-hour mean outside temperature (when it falls below the base temperature). Monthly totals may then be used to compare monthly changes in the weather factor which can be used to take into account the effect of atmospheric temperature on heating demand.

Seventeen climatological centres collect temperatures, maximum and minimum, which are then supplied to the Meteorological Office. Degree day reports showing the monthly total of each month calculated from a base of 15.5°C are published by the Department of Energy in *Energy Management* (available free from Room 1395, Thames House South, Millbank, London SW1P 4QJ).

Table 7 shows how degree days can be used to give accurate comparisons of energy consumption and enable a true assessment of energy saving to be made.

Table 7: Relationship of degree days to energy consumption

Period	**Degree days °C (°F)**		**Fuel consumption litres (gallons)**		**Litres/degree day °C gallons/degree day °F**	
	Year 1	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**
Sept	68 (123)	97 (175)	—	—	—	—
Oct	172 (309)	237 (427)	12,920 (2,842)	9,315 (2,049)	75 (9.2)	39 (4.8)
Nov	286 (515)	236 (426)	21,303 (4,686)	9,488 (2,087)	74 (9.1)	40 (4.9)
Dec	319 (575)	218 (393)	24,176 (5,318)	8,574 (1,886)	76 (9.3)	39 (4.8)
Jan	280 (504)	254 (458)	20,848 (4,586)	9,783 (2,152)	74 (9.1)	39 (4.7)
Feb	274 (494)	291 (523)	20,658 (4,544)	11,411 (2,510)	75 (9.2)	39 (4.8)
March	296 (533)	313 (564)	22,294 (4,904)	12,561 (2,763)	75 (9.2)	40 (4.9)
April	207 (373)	212 (382)	15,770 (3,469)	8,688 (1,910)	76 (9.3)	41 (5.0)
Total Oct/April	1,835 (3,303)	1,763 (3,173)	137,967 (30,349)	69,813 (15,357)	75.2 (9.2)	39.6 (4.8)

Hence saving in Year 2 over Year 1 is more than 47 per cent.

If we take the October figures for oil consumption namely, Year 1, 12,920 litres and Year 2, 9,315 litres, it will be seen that the percentage saving for Year 2 compared with Year 1 was

$$\frac{12{,}920 - 9{,}315}{12{,}920} = 28 \text{ per cent,}$$

but if account is taken of the difference in degree days namely 172 in Year 1 to a much colder 237 in Year 2 it will be seen that the percentage saving in terms of consumption per degree day was

$$\frac{75 - 39}{75} = 48 \text{ per cent.}$$

Table 8: An example of monthly degree days °C (°F) for the Midlands

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
20 years to 1979	94 (169)	171 (308)	286 (515)	360 (648)	379 (682)	343 (617)	320 (576)	238 (428)	156 (281)	79 (142)	48 (86)	53 (95)	2,527 (4,547)
1981/2	69 (124)	227 (409)	246 (443)	502 (904)	428 (770)	307 (553)	303 (545)	218 (392)	154 (277)	49 (88)	36 (65)	47 (85)	2,586 (4,655)
1982/3	83 (149)	179 (322)	240 (432)	356 (641)	276 (497)	403 (725)	284 (511)	270 (486)	176 (317)	68 (122)	21 (38)	36 (65)	2,392 (4,305)

3 *Graphical Presentation*

When sufficient data have been collected, look for a graphical or other relationship between input of energy and output of product. An example of such a relationship is shown in Fig. 5.

This type of relationship may be found for your business for steam or compressed air consumption, electrical consumption, etc.

Further refinements of figures can be made by looking at specific energy input as illustrated in Fig. 6.

By making a graph of energy input per unit of product plotted against product output from a large number of readings, or as a result of trials, it may be possible to pick out a 'best set of figures' which may be used as a target for future output or to optimise the process for energy use.

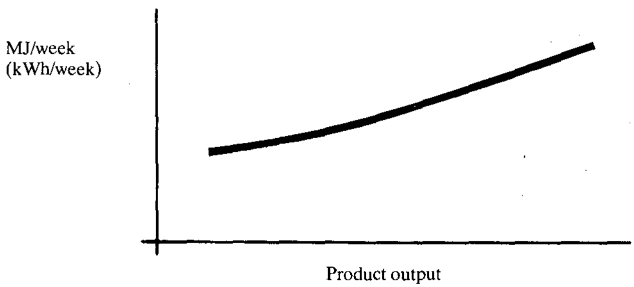


Fig. 5
Fuel input/
product output

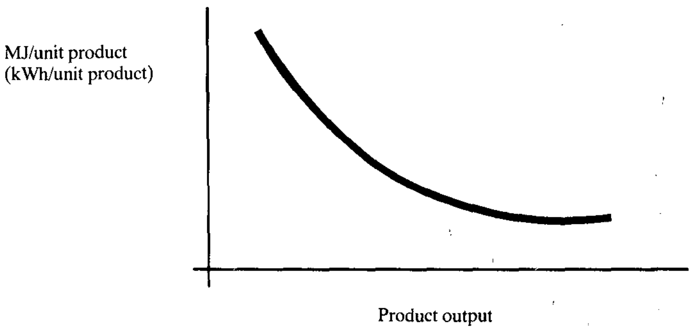
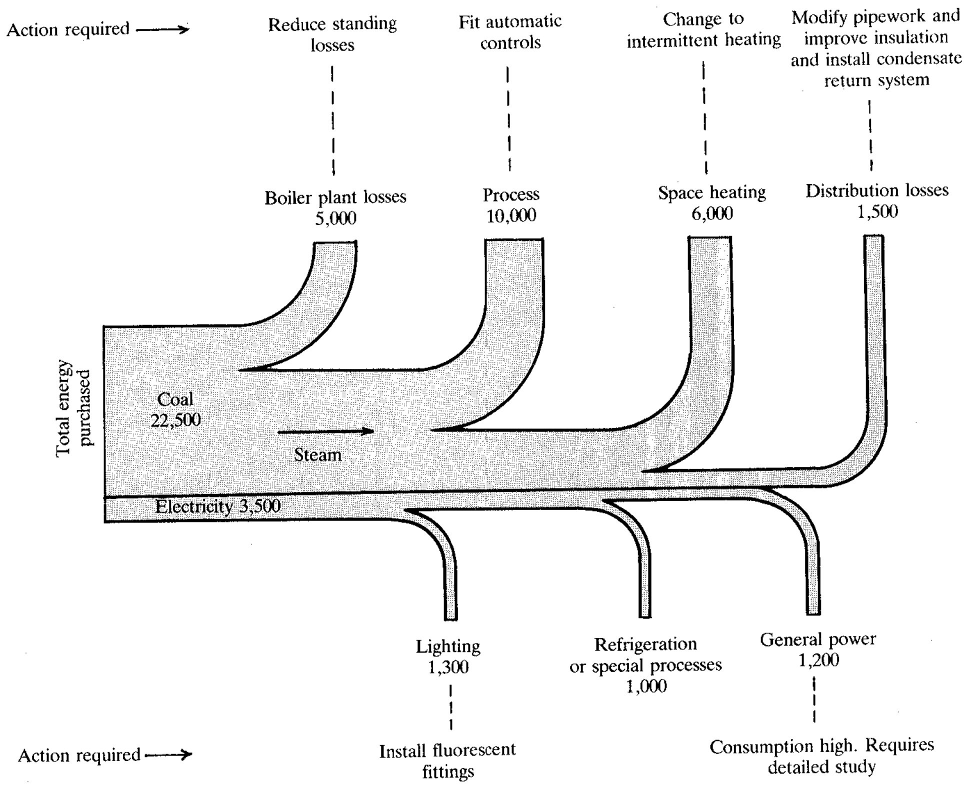


Fig. 6
Specific fuel input/
product output

Experienced fuel engineers use what is called a *Sankey diagram* to provide a diagrammatic way of illustrating energy use and losses. Such a diagram for a small factory is shown in Fig. 7 and it could well be worth your while trying to produce a similar chart for your factory or process. Start with energy units first and then see what the figures look like in money terms — this should give you some idea of where to first start saving energy.

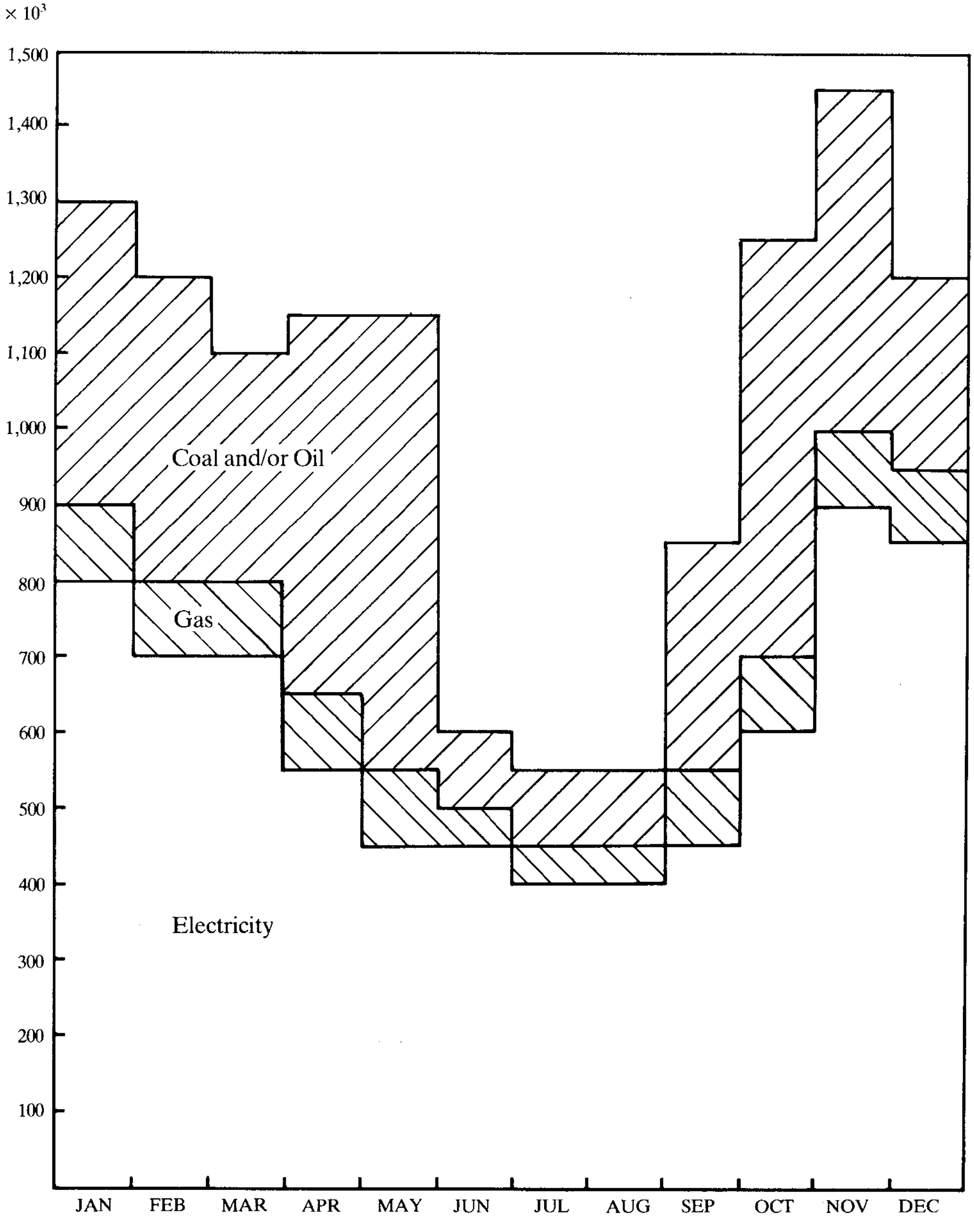
This diagram shows the losses for given rates of inputs of energy, between the energy as purchased and its end use for processes or services: it enables above average losses to be identified, (all units are kWh i.e. 3,412 Btu or 3.6 MJ).

Fig. 7 Simple energy account for a small factory



Appendix 1 Suggested analyses

(a) Load profile (all units are kWh, 3,412 Btu, or 3.6 MJ)
(This type of diagram enables monthly rates of energy consumption to be compared for different forms of energy, anomalies to be identified and most favourable tariff arrangements to be secured.)



Appendix 2 Cash flow on capital expenditure[1]

Detailed description of change in operation resulting from expenditure.
New burner for boiler will increase efficiency.

Gross expenditure	£50,000
Less grants	N/A
Net expenditure	£50,000

(a) Cash flow — assuming purchase

Year	1	2	3
A Cash balance brought forward	£ —	£(33,000)	£(6,500)
B Capital Purchase	(50,000)	—	—
C Fuel Saving	20,000	20,000	20,000
D Writing down allowance (25% per annum)[2] of B on written down value	—	12,500	9,375
E Cash balance	(30,000)	(500)	22,875
F Interest 10% × E	(3,000)	(50)	2,288
G Tax 35%[2] of C+F (one year in arrear)	—	(5,950)	(6,983)
H Net movement (C+D+F − (B+G))	(33,000)	26,500	24,680
I Balance carried forward (A+H)	(33,000)	(6,500)	18,180

Conclusion: Costs recovered in a little over two years.

(b) Cash flow — assuming leasing

Year	1	2	3
A Cash balance brought forward	£ —	£11,000	£19,250
B Leasing payment (20% of cost)	(10,000)	(10,000)	(10,000)
C Fuel Saving	20,000	20,000	20,000
D Written down allowance	Nil	—	—
E Cash balance	10,000	21,000	29,250
F Interest (Say 10% × E)	1,000	2,000	2,925
G Tax 35%[2] of C+F−B (one year in arrear)	—	(3,850)	(4,235)
H Net movement (C+D+F − (B+G))	11,000	8,250	8,690
I Balance carried forward (A+H)	11,000	19,250	27,940

Conclusion: Cash flow is positive from the first year of operation

[1]The method used in the above cash flow tables is intended to be only approximate.
[2]1984 Budget provisions for 1986.

4 *Compare with past and consider future years*

The energy audit can provide a useful check on the deterioration of a plant as it gets older. Energy consumption may rise and the efficiency may fall and the analysis of fuel usage and energy costs will provide a guide as to the correct time for renewal or repair. The audit will help to set meaningful targets for energy consumption within the company.

5 *Include energy in the Company Report*

All the major energy users refer to energy in their Annual Reports. Let the shareholders know that you are making your best endeavours to keep prices down by not wasting energy.

Remember savings in energy costs are immediately reflected as increased profits

For further reading

Dryden, I.G.C., *The Efficient use of Energy*, International Printing Corporation Science and Technology Press, 1975.

Goodall, P.M., *The efficient use of steam*, IPC Science and Technology Press, 1980.

Trotman, G, *NIFES Fuel Economy Handbook*, Dudley Publishers Ltd, 1974.

Department of Energy Fuel Efficiency Booklets

Energy Managers' Handbook, Energy Publications (Cambridge) 1982.

Appendix 3 Energy Units

Whilst the comparison of fuel consumption in the short term may be satisfactory in monetary terms, changes in actual energy use can only be understood by reference to actual energy consumption which is measured in the appropriate energy unit. In the past the UK used the foot pound second derived units but as metrication is progressively introduced energy units will be in SI Units. The following table provides the equivalents of some of the more frequently used energy and related units:

1 Btu = 1.055 kJ
1 therm = 105.506 MJ
1 Btu/ft^3 = 37.259 kJ/m^3
1 therm/ton = 103.839 kJ/kg
1 kWh = 3.6 MJ
1 lb = 0.4536 kg
1 Imperial gallon = 4.546 litres
1 ton = 1.016 tonnes
1 kJ = 0.948 Btu
1 MJ = 0.00948 therms
1 kJ/m^3 = 0.02684 Btu/ft^3
1 kJ/kg = 0.00963 therms/ton
1 MJ = 2.778 kWh
1 kg = 2.2046 lbs
1 litre = 0.2199 Imperial gallon
1 tonne = 0.984 ton

The Department is grateful to the following for the help received in the preparation of this booklet:

Dr. D.N. Gwyther, Teesside Polytechnic;
National Industrial Fuel Efficiency Service Ltd:
National Utility Service Inc (United Kingdom) Ltd:
Spirax Sarco Ltd
The Research Committee of the
United Kingdom Chapter of the Institute of
Internal Auditors

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Prepared by the Energy Efficiency Office of the Department of Energy.
Printed in the UK by Brightman & Stratton Ltd.,
5976AR 11/89 5K